EUROPEAN PROGRAMME ON IMPROVEMENT OF FUSELAGE BURN THROUGH RESISTANCE

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ABSTRACT

Air travel is the safest form of transport since there have been tremendous improvements in aircraft safety.

In addition to the regulatory standards, manufacturers and operators add their own self-imposed safety criteria. These complementary sets of criteria ensure that the aircraft design represents the highest level of safety.

The risk of accidents, which involves fires, cannot be excluded completely, so a continuous enhancement of fire safety in aviation is required.

This paper presents a programme, which addresses the improvement of fuselage burn through resistance and includes perspective from an aircraft manufacturer point of view.

The improvement of fuselage burn through resistance shall lead to the increase of survival times of passengers in a post-crash fire scenario.

Special conditions and requirements of future large double-deck aircraft are discussed.

INTRODUCTION

Airbus Industrie predicts that during the next ten years passenger traffic will grow at an average annual rate of 5.3 per cent and that during the following ten years average annual growth will decline to 4.8 per cent as markets mature (see figure 1).
The number of passenger aircraft with 70 seats or more operated by the airlines will increase to 17.920 at end 2017 from 9.677 at end 1997 (see figure 2).
The overall result will be an average annual growth rate of 5.0 per cent during the twenty-year period of the forecast, meaning that during this time traffic will increase by 168 per cent. In other words, in twenty years time the airlines will be carrying nearly three times as much traffic as today.
With the predicted increase in world air traffic and the move to bigger aircraft the fatalities caused by accidents with fire will increase.

Fire entering the passenger cabin is a major cause of fatalities in aircraft accidents. Fire hardening of cabin materials may become an important issue in order to prolong the safe environment of the passenger cabin in the event of an external fuel fire. In addition interior materials flammability upgrades could increase the time to flash over and provide additional time for passenger escape in a post crash fuel fire scenario.

In Europe, an international industrial consortium led by Airbus Industrie is about to embark upon a coordinated research programme. This programme will build on the work initiated by the aviation authorities.

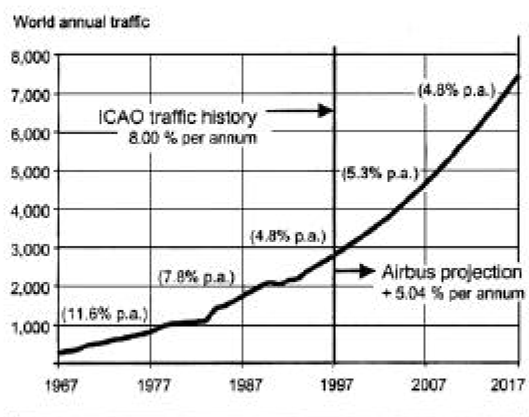

Figure 1 : Growth of Passenger Traffic

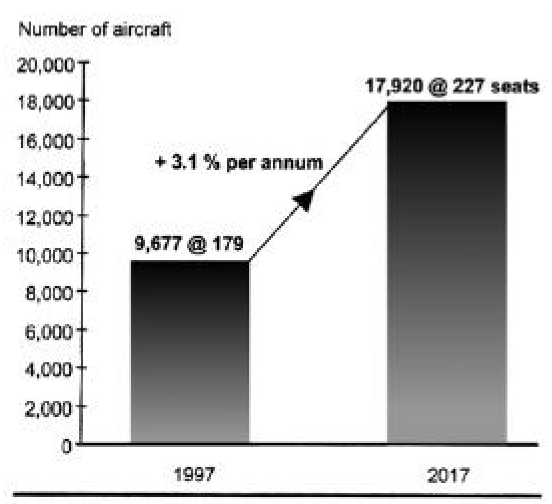

Figure 2 : Growth of Jetliners

EUROPEAN FUSELAGE BURN THROUGH RESISTANCE PROGRAMME

ORGANISATION AND MANAGEMENT STRUCTURE

A consortium which is composed of the following European companies, bodies, university has been set up :

- CAA, Civil Aviation Authority,	United Kingdom
- CEAT, Research Test Center,	France
- Delft University,	Netherlands
- DLR, Research Test Center,	Germany
- DASA, Aircraft Manufacturer,	Germany
- Aerospatiale, Aircraft Manufacturer,	France
- FTC, Research Test Center,	United Kingdom
- Airbus Industrie, Aircraft Manufacturer,	France

Airbus Industrie as programme coordinator will assume responsibility for the project management.

Every opportunity will be taken by the programme participants to advise their national authority and the JAA of progress on the programme. In particular the CAA will undertake to act as coordinator in the relevant committees and working groups to ensure two way communication on the programme and to advise the programme participants of the progress in research into fuselage burn through undertaken by the FAA represented on the International Cabin Safety Research Technical Group.

GENERAL PROGRAMME OBJECTIVES

The initial tasks of the programme will be to develop programme baseline data from studies of accidents and fire tests, to identify the current weaknesses in existing aircraft and study fire penetration of the fuselage.
Current design, production and construction methods of aircraft fuselages will be reviewed.

The test programme will include a correlation of existing small scale, medium scale and large scale test methods. Baselines will be set. The burn through performance of improved materials and designs will be validated. The cost implications and safety benefits of improved materials and designs will be studied.
The findings of the research will be disseminated through the participants to the regulatory authorities, academic institutions and across the aviation industry.

THE TECHNICAL PART OF THE PROGRAMME

The programme has been divided into eight major tasks which have been subdivided. Each major task has an objective and is allocated to a task manager.

Task 1. Project baseline data derived from studies of accidents and fire tests

Task Manager: CAA

Task 2. Review of the design and construction of aircraft fuselages in current production

Task Manager: Airbus Industrie

Task 3. Development of a test protocol

Task Manager: FTC

Task 4. Establish burn through baselines for current fuselage systems

Task Manager: FTC

Task 5. Develop and select materials, processes and designs for hardening the fuselage against burn through

Task Manager: DASA

Task 6. Validation of burn through performance of improved material and design concepts

Task Manager: FTC

Task 7. Study of the cost implication and safety benefits arising from the technical recommendations

Task Manager: Airbus Industrie

Task 8. Final Report

Task Manager: Airbus Industrie

PROGRAMME BUDGET AND TIME SCHEDULE

The Airbus activities are financed by Airbus internal budget without exception. The programme has a duration of two years, starting from May, 1998.

BURN THROUGH TEST FACILITIES

The test programme will include small, medium and large scale tests . Before starting the tests a definition of the relevant size, scale and preparation of test pieces, fire source, temperature, heat flux and test failure criteria is required. Most of these requirements are already available and need to be correlated during the test programme.

SMALL SCALE TEST FACILITY

CEAT has developed a small scale test method (see figure 3) which consists of:

- a kerosene burner as fire source
- a specimen holder
- a smoke chamber.

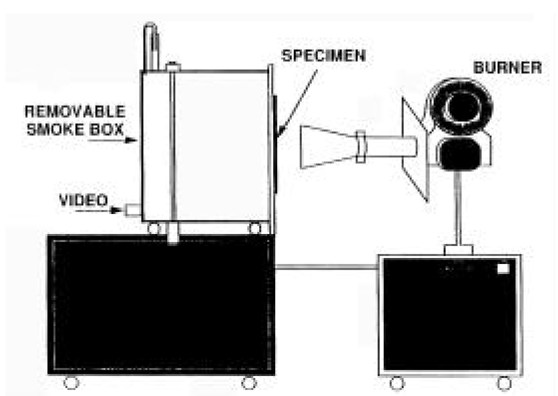

Figure 3 : Small Scale Test Facility

The test method should meet the following criteria:

- good correlation with medium and full scale test results
- easy to duplicate
- low operational costs.

MEDIUM SCALE TEST FACILITY

Faverdale has developed a medium scale test method (see figure 4) which is a dedicated test furnace consisting of a mild steel frame and shell clad with 150 mm thick ceramic fibre insulation. Its internal dimensions are 2m x 2m x 1.5m high.

The furnace is powered by 4 burners firing tangentially into the base of the furnace. The roof of the furnace incorporates a manually operated sliding roof which when rolled back reveals a 1 m square aperture on the top of the furnace. The test piece is held in a frame 250 mm above this aperture.

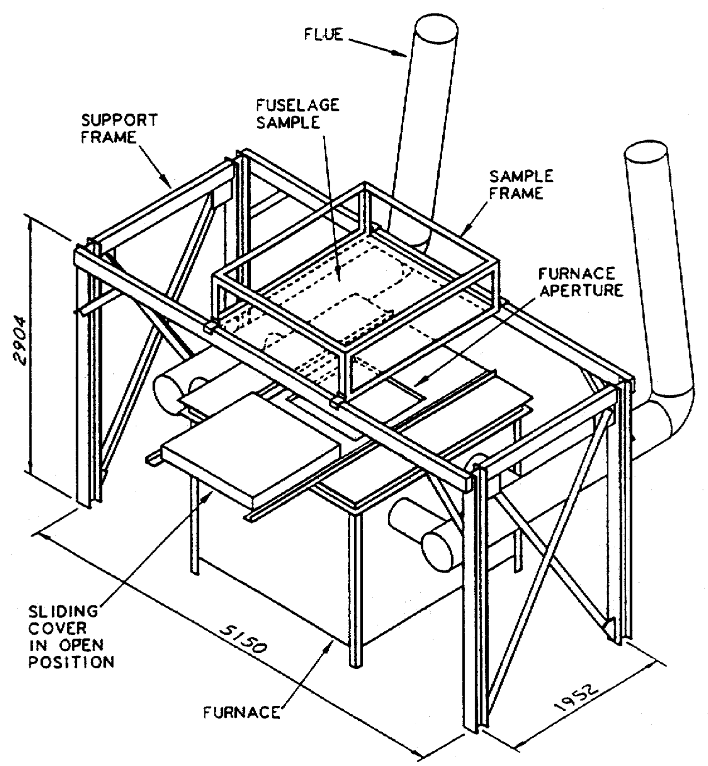

Figure 4 : Medium Scale Test Facility

LARGE SCALE TEST FACILITY

The large scale test facility developed by DASA and DLR (see figure 5) consists of a steel made fuselage rig with a length of 6m and a diameter of 5.6m.
It has a lateral cut-out of 2m x 3m which can be mocked-up with aluminium skin, primary insulation blankets, interior linings and floor panels.
Devices are provided in order to monitor temperature, heat flux, smoke-,toxicity emission and burn through locations and times.

The size and location of the fire pan has been determined.

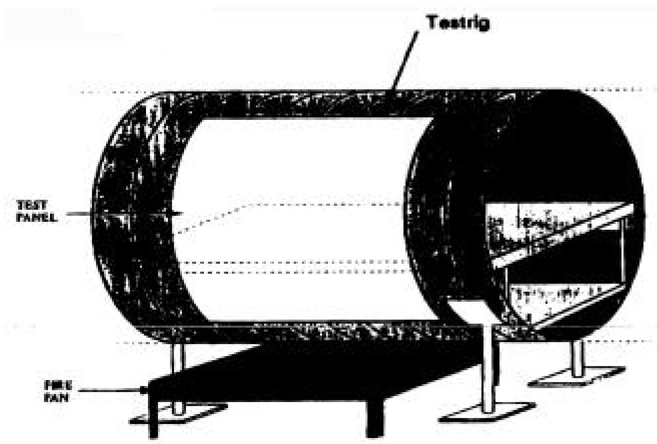

Figure 5 : Large Scale Test Facility

DISCUSSION ON TEST METHODS

The major objective from the industrial point of view is to provide aircraft designers with a means to validate burn through resistance properties in accordance with a small scale test method.
Large and medium scale tests are costly and can therefor not be used for certification purposes but the medium scale test method can serve as a screening device in evaluating new designs.
For validation purposes airframe manufacturers would require a small scale test method similar to that of the regulatory cargo fire containment test facility.

FUTURE CONSIDERATIONS OF NEW MATERIALS AND DESIGNS

Fuselage Materials

It was shown that the aluminium skin of the fuselage provides a burn through protection of 20 to 60 seconds depending on its thickness.

A fuselage constructed of carbon fiber composite would offer improved burn through protection than aluminium but the release of smoke and toxic gases could have a negative impact on escaping occupants.
This has to be determined during the test programme.
The same statement could be made for the use of glare skin material. It is certain that glare provides improved burn through protection and structural integrity of the fuselage in a fire scenario.
However, such solutions would demand a high research effort and would require to establish the viability of these materials and designs with regard to the benefits achievable in structural efficiency.

Insulation Materials

The insulation materials are designed primarily to provide thermal and acoustical insulation.
Further requirements are the resistance to water ingress, non corrosive capabilities and fire, smoke toxicity limits.
Should burn through resistance become an additional requirement then consideration will be given to fire hardened foams, ceramic fibers, silica wool and alternate bagging film materials.

DESIGNS

Sidewall Linings, Floors

Sandwich panels made from honeycomb core and prepreg provide already effective fire barriers.
A further enhancement could be achieved by the use of intumescent coatings which are applied to the backface of the interior or floor panels in order to improve their burn through properties.

Gaps and Seams

Fire can penetrate into the cabin through gaps and seams of both the insulation blankets and interior linings.
From the burn through point of view these features could be improved by overlapping design or the installation of fire resistant materials between gaps and seams.

Attachment Methods

Attachment methods of insulation blankets and interior linings need to receive considerations because it would be essential that the various constructions were retained in place in order to provide a sufficient fire barrier. That means that all these attachment devices would need to be fire hardened.

SPECIFIC LARGE AIRCRAFT CONSIDERATIONS

Fire hardening of cabin materials against burn through may become an important issue in order to prolong the safe environment of the passengers of future large double deck aircraft with a capacity of 500 to 800 passengers.
A safe environment in a post crash fire scenario is required to manage the evacuation of such large aircraft considering the number of slide rafts and the passenger flow control. A further issue of discussion will be fire penetration from the lower deck to the upper deck. (see figure 6).

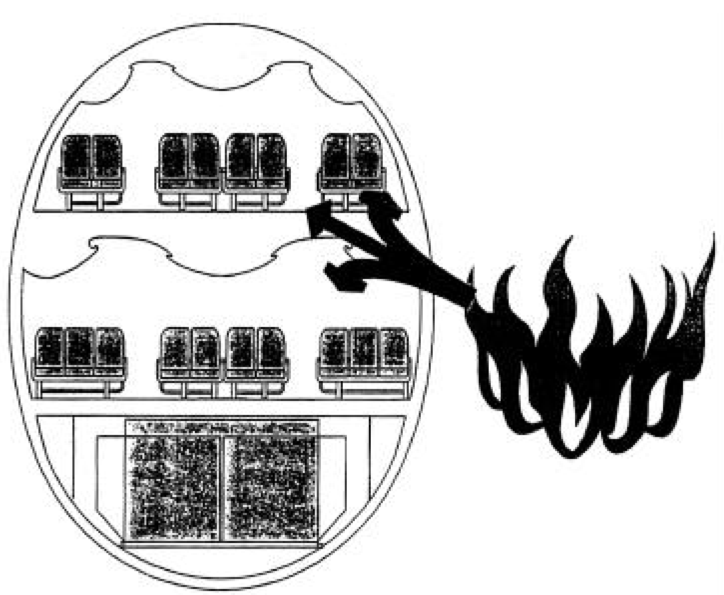

Figure 6 : Future Large Double Deck Aircraft

CONCLUSIONS

Fire safety is a major concern in air traffic. In addition to the regulatory requirements the airframe manufacturers and operators realised supplementary safety criteria in aircraft design. The result of these efforts is that commercial air traffic is the safest transportation mode. That does not mean that no further short, mid or long term safety enhancements are required.
Regulatory authorities, airframe manufacturers and operators are committed to further improve safety.

There are significant factors outside the aircraft design which affect safety as well. These include communication of knowledge and learning, regulation and regulatory oversight, level of flight operation and maintenance procedures, air traffic management and infrastructures.
Any enhancement in flammability standards to improve the survivability of occupants in post crash fires requires studies of its feasibility and benefits. An assessment of the cost of each potential solution needs to be provided. Specific industrial criteria from the airframe manufacturer and operational requirements from the airlines need to be considered if material and design changes will be realised.
During this exercise it is substantial that airframe manufacturers, airlines, regulatory authorities and suppliers work together across national boundaries.

References

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